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ANTIQUITY OF MAN'S BODY-BUILDING INSTINCTS.

By L. C. WOOSTER, Ph. D., Emporia.

LIFE reaches so far back into the dim recesses of the earth's history that the geologist alone is competent to make even an estimate of its antiquity. Furthermore, the geologist is aware that his estimates of the lengths of geological times are merely approximations to the true periods; still, these eras of time are so vast that it is beyond question entirely safe to use these estimates for most scientific purposes. Averaging the opinions of several leading geologists, we may give the lengths of the eras as follows:

Archean	10+	million years.
Proterozoic	17½	" "
Cambrian	6	" "
Ordovician	6	" "
Silurian	2½	" "
Devonian	3½	" "
Carbonic	4½	" "
Jura-Trias	3½	" "
Cretaceous	3½	" "
Tertiary	2	" "
Quaternary	1	" "
Total	60+	million years.

Before giving the times of appearance of the several body-building instincts, it will be necessary to discuss briefly the signification of this new term in biology.

An instinct has been defined as a propensity of each individual to do those things which reason afterwards pronounces to be good, and which were done prior to experience and independent of instruction.

Professor James says that an instinct is usually defined as the faculty of acting in such a way as to produce certain ends, without foresight of the ends, and without previous education in the performance. (Psychology, Brief Course, page 391.) Professor James further says that instincts are functional correlatives of structure, and that with the presence of a certain organ goes almost always a native aptitude for its use. This organ is used in response to a certain stimulus, says Professor James, and this stimulus may be a sensation, as

hunger and cold; a perception, as the sight of food or fire at a distance; or an idea stimulus, as the remembrance of a previous dinner or warm place brought to mind by a growl or the sound of a distant whistle. The illustrations of these three kinds of stimuli are in part mine.

Sensations and perceptions are objective stimuli to the use of the organs of the body; ideas are, in some measure, subjective stimuli; but a fourth and very important class of stimuli is purely subjective. Prof. Joseph Baldwin (*International Education Series*, vol. VI, p. 16) calls this fourth group of stimuli blind impulses implanted by the Creator, and Professor James terms these subjective stimuli native aptitudes for the use of the various parts of the body.

These blind impulses, these native aptitudes, must inhere in the life of the body, for life alone is static as it develops its powers in the midst of the stream of matter passing through the body, and life alone can inherit the capacities and tendencies of ancestral life.

It may be a relief to all psychologists who read this paper to be reminded that the *Dictionary of Philosophy and Psychology*, edited by Prof. J. Mark Baldwin, defines instinct as an inherited reaction of the sensori-motor type, relatively complex and markedly adaptive in character, and common to a group of individuals. The dictionary further says (page 555) that it is definitely a biological and not a psychological conception; that no adequate psychological definition of instinct is possible, since the psychological states involved are exhausted by the terms sensation (and also perception), instinct feeling, and impulse.

The *Dictionary of Philosophy and Psychology's* definition of instinct rules out, on the one hand, the application of the term instinct to tendencies and impulses which do not have definite native motor channels of discharge, and, on the other, those reflexes that are simple and not adaptive.

As the term instinct is strictly a biological term, it may be modified in any way to suit the special needs of a study of life activities. It has seemed wise to the writer, therefore, to restrict the term "instincts" to those powers of life by which the several parts of the body are used without instruction to gain appropriate, beneficent ends; and to use the term "body-building instincts" to designate those powers of life by which the several parts of the body were made for some beneficent

use in accordance with the practice of a long line of ancestors. Both body-building and body-using instincts are adaptive and mutually reactive, a changing use inducing a changing structure, and a changing structure making possible a more rapidly changing use.

In the developing embryo life begins all the parts of the body and completes several of them before the little organism has any use for these structures. Thus the digestive and respiratory apparatuses are ready for use before food and air can enter them, and the blood-vessels and muscles are begun before they are needed. So use by an ancestor determines structure in a descendant, and not the operation of chance or the effect of an external environment. Where use varies in the parent, the structure and use vary in the descendant, but only to an almost infinitesimal degree, fortunately, in all but a very few of the descendants.

Even a careless observer must have noted that the lower animals possess body-building instincts and instincts proper very much like our own. The evolutionist has inferred, because of this and other reasons, that the higher animals have been evolved from the lower ones, not suddenly, but by the accumulation of infinitesimal variations through long eras of time, many millions of years in duration.

It would not be germane to the purpose of this paper to attempt to prove the correctness of this view of the evolutionist. Indeed, so few now hold the contrary theory such an attempt would scarcely be necessary under any circumstances. It may be well, however, to mention one confirmatory proof which has many interesting bearings on the subject we are considering.

Professor James says that certain instincts in man become habits if the tendencies are used consciously in the performance of work; otherwise these instincts become dormant and may never be fully functional during the lifetime of the individual. In like manner, as has been already stated, the body-building instincts become weakened in the descendant if the part to be made had not been used by its ancestors; and such parts become vestigial in remote succeeding generations if the disuse is persisted in. The eyes of the cave-fish have undoubtedly become vestigial in this way; and man's ancestors have discontinued the use of so many parts that one anatomist, Wiedersheim, declares that he has found 180 parts in man's

body which are vestigial. On the other hand, our ancestors have used various parts and organs to an increasingly greater extent than the same parts and organs were used by our still more remote progenitors, with the result, as it is hoped this paper will show, that the parts and organs appear in the following generations down to man of the present time with more and more complex structures and greatly increased functions, all because the life-powers are educable.

The most primitive of all organs in the bodies of animals is the digestive cavity. This statement is supported by the embryologist, the evolutionist, and, in a somewhat indirect way, by the paleontologist.

The embryologist finds that the fertilized eggs of all metazoa become in succession morulas, blastulas, simple gastrulas, and complex gastrulas, as they develop. This in itself would not be especially interesting had not the embryologist discovered that these stages of development of the embryo possess counterparts in a series of adult animals of lower classification. Thus he finds the following corresponding forms:

Fertilized egg	Hematococcus.
Morula	Pandorina and eudorina.
Blastula	Volvox.
Simple gastrula	Fresh-water hydra.
Complex gastrula	Worm, amphibian, reptile (Theriodonts), lower mammal, man.

The evolutionist explains this remarkable series of corresponding structures by calling attention to the fact shown in geology that the lower forms of life appeared on earth first, and then successively higher forms, such as: Protozoa, cœlenterates, worms, fish, amphibians, reptiles, lower mammals, and, lastly, man. The law of development he has found to be such that only one in a million of each species develops structural characteristics of higher importance, while the other 999,999 have remained like their ancestors. The descendants of these stay-behinds remain on earth to-day little changed, except in minor details of structure, and thus serve to show to the evolutionist what his ancestors have been back to the beginning.

In this list of ancestors we find that the sponges and cœlenterates were the first to take the gastrula form, and thus were the first to possess a true digestive cavity. The paleontologist finds by a study of the fossils of the earth's crust that sponges and cœlenterates were common in the Cambrian era, but with

much higher forms, such as worms, mollusks, and trilobites. He hence infers that the sponges and coelenterates, the first animals with digestive chambers, appeared on earth before the Cambrian, in the Proterozoic era, at least forty-five million years ago. It seems possible, then, that the stomach-making instinct has required these forty-five million years to evolve a digestive apparatus as complicated as that possessed by the ox and man.

This digestive chamber was merely a sac with one opening in the coelenterates; it became a tube with two openings in the worms, if we are to accept as representative of the Proterozoic type of worms the modern, stay-behind examples of these animals; a tube with various enlargements and associated digestive glands in the amphibians thirty-five million years later; and became fully differentiated for animal and vegetable food in the mammals some two million years ago, since which time life has evolved little that is new in the construction and operation of a stomach, unless we add its ability to get out of order in man.

A system of tubes for conveying blood to remote parts of the body is found now in its simplest form among the worms, and worms of the higher types certainly existed twenty-seven million years ago, as shown by fossil worm holes and casts found in the Potsdam sandstone of the Cambrian era. These may have had one-cavity hearts, as earthworms do to-day. Fish with two-cavity hearts existed in the Silurian era, over eight million years later; amphibians with three-cavity hearts were abundant twelve million years ago, in the Carbonic era, and primitive mammals with four-cavity hearts were numerous seven million years ago in the Jura-Trias; since which time the heart-making instinct has not improved much, except in the direction of making larger-hearted individuals.

Ventral nerve-threads to control the food-digesting and distributing organs probably appeared first in the worms twenty-seven million years ago. This ventral nerve-cord producing instinct is certainly so old that man has no conscious control over this system of nerves, the sympathetic system.

The dorsal nerve-cord was originated by an instinct which appeared much later in the development of life. As is now known, the dorsal nerve-cord is formed from a dorsal furrow-invasion of the ectoderm of a worm-like animal, and was made primarily to control an increasingly complex system of

muscles in the lower chordates, fish and higher animals. The ventral nerve-cord does this in the arthropods, in addition to managing digestion and circulation; but this double work on the part of the ventral cord in crustaceans and insects has been fatal to their higher development; and vertebrates with two nerve systems and division of labor have far outstripped arthropods in the race to greater complexity. The dorsal cord must have appeared with and in the lower chordates and fish of the Silurian era, twenty million years ago. A special development of this dorsal nerve-cord at its front end and near the organs of special sense, which we call the brain, appeared in fish, so the geologist tells us, in the Silurian era, over twenty million years ago. This instinct for brain-building did not improve much till mammals appeared, twelve or fifteen million years later, in the Jura-Trias. The intricate land life of the true mammals of the Tertiary era induced a rapid development of the brain-building instinct, especially in the production of a larger cerebrum and cerebellum, till it culminated in man after he appeared, 100,000 years ago. The organs of special sense have developed with the brain, as we would naturally expect.

The instinct for building a backbone also appeared with and in the primitive fish; but the first backbone was not at all bony, for it was merely a cartilaginous rod produced from a longitudinal furrow-invagination of the alimentary canal. Millions of years later it became segmented and bony, as we find it in the higher vertebrates, and received its peculiar curves as in man.

The aquatic habits of the early animals permitted the use of the entire ectoderm of the body, increased by evaginations or invaginations in some cases, in oxygenating the blood; but the increasing activity of the more and more complex aquatic animals made it necessary to expose some of the entoderm to water containing oxygen. This was more especially true of those animals which thickened the outer skin for service as an armor to protect them from their foes. Obviously the entire entoderm could not be used for purposes of respiration, so certain anterior portions near the mouth, as we know, were invaginated, forming sacs or pouches which communicated with the exterior through pores or slits. It is true that the gastrula-animals, such as the hydra and sponge, probably did attempt to use the entire entoderm for both digestion and

respiration, as they do to-day; but both kinds of work were poorly done, and part of the digestion must have been performed, as now, in the entodermal cells, making digestion in part cellular, as in modern protozoa. We know that recent hydras and fresh-water sponges use algæ, such as the *protococcus*, to assist in the work of respiration.

The whirlpool method of respiration in pouches used in hydras, polyps, snails, lampreys and hags must have originated in the Proterozoic era in sponges and hydras. Outlet for the water must have been given then, as now, where it entered, or through pores and slits at the bottoms of the pouches.

But when the land habit was acquired, the drying influence of the atmosphere made it necessary to give up using the ectoderm as a respiratory membrane, except incidentally, and to make an increased use of sacculi of the entoderm. The mammalian embryo still retains the instinct for making sacs, slit so as to form gills; but these generally close before birth, and deeper-seated invaginations, many times sacculated, serve as respiratory organs or lungs.

The last organ-making instinct which my space will permit me to mention has for its function the preparation of limbs for locomotion. The earlier animals, so we learn from the geologist, either spread themselves over the sea-bottom, or were radially symmetrical with their axes in a vertical position. The equilibrium of such animals was easily maintained, but they were usually poor travelers. Worm-like animals were possibly the first good swimmers. That these long animals might not roll over and over, the body must have been flattened dorsi-ventrally and the sides extended by lobe-evaginations, as we find in the *Nereis* of modern seas. Eventually certain of these lobes must have become specialized as limbs for locomotion, as in centipedes, insects, fish, salamanders, and mammals.

As the mammals became better and better adapted to the land habit of living, the ends of the subdivisions of these evaginations became covered with hardened scales of the epidermis. These eventually became the hoofs of the herbivorous mammals, the claws of the carnivores, and the nails of man.

As one studies the evolution of the body-building instincts from perhaps a single primitive instinct that made its appearance on earth fifty or sixty million years ago, as one learns that these instincts grew and branched as the parts which

were consciously overused within safe limits, or were consciously disused till they dwindled and became vestigial, one's amazement certainly grows that life should have been able in this slow way to have produced such a diversity of parts and organs, all adapted to such a variety of uses and environments.

Where twenty million years could be used by a long series of life-units in the development of a single organ, such as man's brain, and a succession of one million individuals could each use or disuse the developing parts of this wonderful organ and each transmit to his descendant in the tiniest degree the tendency to build the parts used or disused in such a way that they may be used or disused more or less than they had been before, no difficulty should be experienced by any one in understanding how greatly complicated organs are produced and higher types of animals evolved.

A myriad of tiny conscious efforts of the same kind may make a habit, and why may not habits persisted in for thousands of generations, as geology and biology seem to show—why may not such habits become fixed in life and the tendency to form these habits be transmitted to the following generations? These inherited tendencies may well be termed sub-conscious habits, or semi-instincts, which in millions of years more may become true body-building and body-using instincts independent of direct conscious control. Unfortunate tendencies would be ended by natural or artificial selection, as was abundantly demonstrated by Darwin, and useful variations be strengthened by organic selection plus tiny increments of conscious control continued for millions of years through millions of individuals.

Many advocates of Mendelianism try to explain the inheritance of body-building and body-using instincts from two lines of ancestors, that of the father and of the mother, by imagining that the sperm and egg chromosomes, when they fuse in synapsis, intermingle their biophores and thus give to the embryo which develops from the fertilized egg a mixture of biophore-corpuscles, some dominant and some recessive in their influence.

A simpler form of explanation and therefore a better one, a form based on life and its activities and less largely on matter in its inertness and therefore truer, consists in making the fusion in synapsis one of life-instincts and not chiefly one of corpuscles of matter whose arrangement determines, in some

unknown way, the character of their reaction with their environment. When the instincts harmonize they supplement and strengthen one another, as is usually the case when the sperm and egg come from individuals of the same species. When the body-building and body-using instincts cannot harmonize, as is the case when the sperm and egg come from individuals of widely different species, the result is zero, for very obvious and necessary reasons.